INTRODUCTION

This report will outline the use of PCBs as they impact the HMAS Adelaide relating status of manufacturing, purchasing, construction to the phase out of PCBs in the United States and in Naval/Commercial Ship construction in the United States.

The following information is attached:

Annexure A – Resume
Annexure B – Letter of Instructions
Annexure C – NAVSEA Advisory 95-1
Annexure D – USEPA Press Release 19 April 1979
Annexure E – PCB Monitoring on the Oriskany Reef
Annexure F – Sample Chain of Custody
Annexure G – Adelaide drawing with notes on locations of RPC & MSDS

In addition to the documents referred to in the Letter of Instructions from the Applicant's solicitors (Annexure B), I have subsequently been provided with the following documents:

1. Section 37 Documents (T Documents):
    a. T55 – Email by N Heise, Ex HMAS Adelaide Artificial Reef Project - Lead Ballast, 23/09/09,
    b. T56 – Email by T Venables, Ex HMAS Adelaide Artificial Reef Project - Lead Ballast, 25/09/09,
    c. T58 – Email by J Polglaze, Ex HMAS Adelaide Artificial Reef Project - Lead Ballast,
    d. T115 – Material Safety Data Sheets,
    e. T142 – Email by D Venables, Ex HMAS Adelaide: PCB Testing, 04/03/10,
    f. T159 – email by N Heise, Ex HMAS Adelaide - Cabling Removes, 10/03/10,
    g. T167 – Email by D Venables, HMAS Adelaide Process, 12/03/10,
    h. T186 – File Note by D Venables, 17/03/10;
2. Daily worksheets of material removed from the ex-HMAS Adelaide (62 files between 1 September 2009 and 9 February 2010);
3. Summary spreadsheet of the weights removed from the ex-HMAS Adelaide August 2009 – February 2010 ("weight removal log");
4. Waste consignment notes showing waste material removed from the ex-HMAS Adelaide (18 dockets);
5. Stevens (2001) *The Royal Australian Navy*, pages 220, 221, 224.
6. Affidavit of Mr Quentin Riley dated 15 March 2010 (and electronic copies of the photos in the Annexures to that affidavit).

Basic Information: Polychlorinated Biphenyl (PCB) PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs also classified as Persistent Organic Pollutants (POPS). PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. They have a range of toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications.[1]

1. EX-HMAS ADELAIDE

1.1 Type of vessel

HMAS Adelaide[2] is an FFG-7 Oliver Hazard Perry[3] Class Gas Turbine Frigate Built for the Royal Australian Navy. The FFG-7 class consisted of 55 ships, 51 delivered to the US Navy and 4 delivered to the Royal Australian Navy. Construction of the first ship began in 1975 and was commissioned in 1977, with the last ship constructed in the class of ships completed at Todd Shipyard Los Angeles and commissioned on 5 August 1989.

[1] http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/about.htm
[2] The Royal Australian Navy, David Stevens, 2001, p. 220
[3] http://www.fas.org/programs/ssp/man/uswpns/navy/surfacewarfare/FFG7_oliverhazardperry.html

1.2 Vessel characteristics[4]

Displacement	4,100 tonne
Length	138 metres (453 ft)
Beam	14.3 metres (47 ft)
Draught	7. 5 metres (25 ft)
Propulsion	2 × General Electric LM2500 gas turbines, each providing 20,500 horsepower (15,287 kW). Total 41,000 horsepower (30,574 kW)
Speed:	Over 30 knots (56 km/hr)
Complement	221
Sensors and processing systems	AN/SPS-49; AN/SPS-55; AN/SQS-56; AN/SLQ-32(V)2
Armament:	• Mk 13 launcher for Harpoon and SM-1MR missiles • 1 × 76 mm OTO Melara gun • 1 × 20 mm Mk 16 Mod 2 Phalanx CIWS • 2 x triple 324 mm Mk 32 torpedo tubes
Aircraft carried:	2 x S-70B Seahawk

1.3 Breakdown of major ship components

Table 1.3
Materials Weight Data from Naval Institute Press Sources,
Gas-Turbine Powered Frigates and Destroyers
(percentage of LSW)[5]

ESWBS	FFG7 Perry (2,648 LSW tons)	DD963 Spruance (5,826 LSW tons)	Gas Turbine DD/FF Avgs.
1: Hull and structure	47	53	50
2: Propulsion	10	13	12
3: Electrical	4	5	5
4: Cmd/surv	4	6	5
5: Aux	17	13	15
6: Outfitting	12	8	10
7: Armament	4	3	4
Margin	—	—	

1.4 Details of construction

Four ships of the FFG-7 Class were constructed by Todd Shipyard, Seattle, USA. FFG-17 Hull became the HMAS Adelaide (FFG-01), the first of the four ships to be delivered to the Royal Australian Navy. US Hull number 17, 18, 35, and 44 became the RAN FFG-1 class, an additional two hulls were built in Australia under license.

The following cite from Stevens (2001):

The order was placed with Todd Pacific Shipyards at Seattle, Washington in February 1976. *Adelaide* was laid down to the *Perry* class' Flight I design on 29 July 1977, launched on 21 June 1978, and commissioned into the Royal Australian Navy on 15 November 1980. During

[4] The Royal Australian Navy, David Stevens, 2001, p. 22
[5] Hess, R. et. al. (2001) *Disposal options for ships*. Appendix B Table B.4 http://www.rand.org/monograph_report/MR1377/MR1377.appb.pdf

construction, she was identified with the United States Navy hull number FFG-17. Three more *Adelaide* class ships were constructed by Todd Pacific, with a further two built by Australian shipbuilder AMECON.

1.5 Modifications made to the ship after it was commissioned in 1980

PERRY-class ships were produced in two variants, known as "short-hull" and "long-hull", with the later variant being eight feet longer than the short-hull version. The long-hull ships [FFG 8, 28, 29, 32, 33, 36-61] carry the SH-60B LAMPS III helicopters, while the short-hull units carry the less-capable SH-2G. These ships have a full load displacement of that ranges from 3,658 tons to 4,100 tons, are either 445 or 453 feet in overall length, have a 45 foot beam and a draft of 22 feet.[6]

Adelaide's present displacement of 4100 LT indicates that she was constructed as a long hull or later the conversion from short hull to long hull was accomplished.

The bulk of PCBs would have been contained in the ship's power and distribution wiring harness. This use would have accounted for approximately 95% of the total PCBs onboard.[7]

Various systems upgrades modified warfare capabilities to maintain warfare proficiency. Upgrades installed after the mid-1980 would have reduced the quantities of PCBs onboard both solid/liquid as new equipment with fewer PCBs or PCB free was installed.[8]

As part of the equipment upgrade process electronic and weapon systems were exchanged as part of the overhaul process under Naval Sea Systems Command (NAVSEA) logistics support for equipment overhaul. Upgrades were typically on a 3 to 5 year cycle. The NAVSEA division NAVELEX (Naval Electronics) is currently NAVSEA SPAWAR (Space and Warfare) Division. This division continues accomplished depot level maintenance for Radar Systems, Command and Control Systems, Communications Systems, and Weapons Systems either directly or through defense contractor support[9].

Impact in reduction of PCBs through maintenance and modernization is considered minor as it impacted 5% or less of the total PCBs onboard[10].

2. PCB use in ships constructed in the US in the 1970s

2.1 General comment: PCBs due to both their electrical properties as well as their fire retardant properties were utilized extensively in both Naval and Commercial Ship Construction. PCB control and management had become a major priority with the US Navy in the early 1990's due to the problems presented in waste stream management, disposal, and regulatory compliance as well as personnel safety.

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[6] http://www.fas.org/programs/ssp/man/uswpns/navy/surfacewarfare/FFG7_oliverhazardperry.html

[7] Experts experience in the relative quantities of PCBs encountered shipboard. Breaking 4 Knox Class ships in 2000-2009 and

[8] Expert's experience as a US Naval Engineering Duty Officer in executing ship repair and modernization at Long Beach Naval Shipyard, Mare Island Shipyard, US Naval Ship Repair Facility Subic Bay, Supervisor of Shipbuilding, Conversion and Repair,Long Beach, Cascade General Shipyard, Portland Oregon.

[9] Expert's - Ship repair Experience

[10] Expert's estimate based on experience.

2.2 Use of PCBs in ships constructed in the US after the *1973 OECD Agreement: protection of the Environment by Control of Polychlorinated Biphenyls*

I have read the 1973 OECD agreement in its entirety. The agreement did not ban PCBs completely. It established a process for control, import, export, and handling. Part 1 was an agreement to ban use of most PCBs.

Continued use of PCBs was allowed under para 1 of the OECD decision regarding PCBs.

> *1. Member countries shall ensure that in their respective territories, Polychlorinated Biphenyls (PCBs) shall not be used for industrial or commercial purposes, except in the following categories of use:*
>
> *a) Dielectric fluids for transformers or large power factor correction capacitors;*
>
> *b) Heat transfer fluids (other than in installations for processing of foods, drugs, feeds and veterinary products);*
>
> *c) Hydraulic fluids in mining equipment;*
>
> *d) Small capacitors (subject to the provisions of Section II.2 below);*

The allowed uses fall into applications heavily utilized for industrial purposes under which both naval and commercial shipping construction fall. Many countries and manufacturers construed this to apply to the manufacture of electrical cabling – solid matrix[11] application. The use of liquid PCBs with felt gaskets would have been covered by the agreement and not considered an exception.

Para 2 of OECD outlined goals and invited members to submit reports in 1974, 1975 and 1976 regarding status.

The 1973 OECD agreement was not ratified by many of the countries manufacturing PCBs until much later. In the case of the United States it has never been ratified. It was approved and signed under the 2001 Stockholm Agreement to ban Persistent Organic Pollutants (POPs) by President Bush but not ratified by Congress as of this date.

[11] Solid matrix – the flexible insulating fill material between insulated conductors in an electrical cable assembly.

2.3 Key steps leading to the reduction of PCB use in the US

The timeline below shows/explains the regulatory process as it has evolved in the U.S. relating to (a) elimination of PCBs in manufacturing, use and disposal; and (b) subsequent impacts on ship reefing and disposal.

Year	**Event**
1973	OECD Agreement
1976	US Congress passed the Toxic Substances Control Act (TSCA)[12] which outlawed the manufacture, sale, and distribution of PCBs except in "totally enclosed[13]" systems, within 3 years. **TSCA** became law on October 11, **1976** to become effective on January 1, 1977. It was the only chemical Congress itself has ever banned. However, enclosed transformers and capacitors were STILL allowed to contain PCBs
1979	April 19, 1979 US EPA issues press release implementing TSCA regulations regarding ban – (Final rule issued April 19, 1979) on manufacture of PCBs and phase out of uses. This is the Start of PCB phase out of products utilizing contained PCBs in Electrical, electronic, heat transfer applications.
1994	Sept 1994-Dec 7, 1994 – USS Bennington remediated for PCBs to Export. Sampling test and remediation plan developed by Steve Paulsen of Paulsen Environmental and Jack Billings of Alpine Abatement Associates Inc to remediate the Ex-USS Bennington for PCBs to meet EPA export requirements (WWII aircraft carrier for export). Requirement to export in 1995 was ≤ 50 mg/Kg levels of PCB content in materials.[14]
1995	In 1995 as a consequence of identifying PCBs for disposal in the Naval Shipyards through work at Puget Sound Naval Shipyard and Norfolk Naval Shipyard, the US Navy Naval Sea Systems Command issued Ship Reuse/Disposal Guidance for testing NAVSEA Advisory 95-1 regarding testing for PCBs. This tied to EPA regulatory guidance requirement for export of ≤ 50 mg/Kg levels of PCB content. 1995 EPA Draft Guidance developed for export of ships. This document was never officially released by the EPA. EPA today reviews each project on a case basis. Guidance document was developed as a result of the test and remediation plan developed to remediate the Ex-USS Bennington for PCBs to meet EPA export requirements. The requirement to export in 1994 was ≤ 50 mg/Kg levels of PCB content in materials.
1996	Congress institutes moratorium on export of US Government ships for scrapping. USS Bennington was 1st and last hull remediated for export.

[12] http://www.epa.gov/oecaerth/civil/tsca/tscaenfstatreq.html
[13] Totally enclosed system – refers to sealed containment or boundary. Examples are sealed metal capacitors, transformers utilizing liquid PCBs. Jacketed cabling with the matrix fill material impregnated with PCBs.
[14] Mr Billings is a professional associate who has worked closely with the author in preparation of ship disposal compliance planning from 2004 to present.

Year	Event
2000	A Guide for Ship Scrappers: Tips for Regulatory Compliance -Federal Facilities Enforcement Office - a resource and guidance document for those involved in ship scrapping/breaking industry (2000)[15] US Department of Health and Human Services – Agency for Toxic Substances and Disease Registry publishes summary of manufacturing utilizing PCBs. Toxicological Profile for Polychlorinated Biphenyls (PCBs) November 2000[16]
2000	2000 California Hazardous Waste Regulation apply to all materials containing PCBs ≥ 5 ppm (mg/Kg) References are California Code of Regulations Title 22 Section 66261.24 and SB-842 (California State Senate Bill-842).[17]
2001	2001 May 21 Stockholm Convention on Persistent Organic Pollutants. US approves 23 May 2001. This document represents the approval of the 1973 OECD Agreement. Not ratified by US Congress as of 2010.[18]
2002	November 2002 Congress lifts export Moratorium allowing export of 4 MARAD[19] ships to UK for dismantling.
2006	National Guidance: Best Management Practices for Preparing Vessels Intended to Create Artificial Reefs (2006 May)[20]- In response to a Maritime Administration request, EPA established and led an interagency workgroup to develop best management practices to be used in the preparation of vessels for use as artificial reefs. This guidance identifies materials or categories of materials of concern that may be found aboard vessels and specifically identifies where they may be found. For each material or category of material, the document provides a narrative clean-up performance goal and information on methods for achieving those goals in preparation of the vessel prior to sinking. Materials of concern include, but are not limited to, fuels and oil, asbestos, PCBs, paints, solids/debris/floatables, and any other materials of environmental concern (e.g., mercury and refrigerants).

More than 1.4 billion pounds of PCBs were manufactured in the United States prior to cessation of production in 1977.[21]

A period of 3 years 1976 to 1979 elapsed before the regulatory rules were made final and implemented. The EPA press release citation (ANNEXURE D) reflects the phase out of uses over the next 3-5 years, with phase out planned to be complete about 1984.

[15] http://www.epa.gov/Compliance/resources/publications/civil/federal/shipscrapguide.pdf
[16] http://www.atsdr.cdc.gov/toxprofiles/tp17.html
[17] The 5 mg/Kg threshold was the CA regulatory requirement for Manifesting and transporting materials to approved disposal sites during Experts ship disposal experience from 2000-2001.
[18] Stockholm Convention on Persistent Organic Pollutants http://www.pops.int/documents/signature/signstatus.htm
[19] MARAD – Maritime Administration, US Department of Transportation
[20] http://www.epa.gov/owow/oceans/habitat/artificialreefs/index.html
[21] Status of PCB Management in North America, COMMISSION FOR ENVIRONMENTAL COOPERATION MONTREAL, CANADA JUNE 1996 http://www.cec.org/Storage/43/3496_pcbe_EN.pdf

US EPA Citation : Commercial Use of PCBs[22] Although no longer commercially produced in the United States, PCBs may be present in products and materials produced before the 1979 PCB ban. Products that may contain PCBs include:

1. Transformers and capacitors
2. Other electrical equipment including voltage regulators, switches, reclosers, bushings, and electromagnets
3. Oil used in motors and hydraulic systems
4. Old electrical devices or appliances containing PCB capacitors
5. Fluorescent light ballasts
6. Cable insulation
7. Thermal insulation material including fiberglass, felt, foam, and cork
8. Adhesives and tapes
9. Oil-based paint
10. Caulking
11. Plastics
12. Carbonless copy paper
13. Floor finish

2.4 Phasing out PCB use in ships built in the US

PCB use in ships ceased as the manufacturing process utilizing PCBs ceased manufacturing electronic components, wiring, adhesives and paints utilizing PCBs. This phase out occurred primarily from 1978 to 1986. In controlling PCBs, the Naval Shipyard Puget Sound[23] developed a testing program which identified PCBs in many locations during ship disposal in the late 1990's. The basis of this testing was NAVSEA Advisory 95-1 which provided Navy Activities with a mechanism to methodically identify PCBs on ships. This coupled with the USS Bennington PCB Cleanup experience with Joint US Navy and US EPA monitoring formed the methodology by which the EPA has approved individual clean up projects since and developed its Draft Guidance – Sampling Ships for PCBs Regulated for Disposal, November 1995. Document was not officially released.

Due to the nature of the Navy Logistics System and sourcing of products the Navy had found PCB materials on ships and ashore. Review of Logistics guidance documents held for the Naval Supply System (Naval Logistics Library 1995 publication) held no reference to PCBs or Poly Chlorinated biphenyls whatsoever. The consequences were continued low level sourcing of materials containing PCBs from foreign manufacturers entering the US Navy procurement system. The US Navy implemented a post-1995 change in **OPNAVINST 5090.1**, Environmental and Natural Resources Program Manual (OPNAVINST 5090.1B Ch1 2/2/98 Ch 10/17/03, OPNAVINST 5090.1C[24] 10/30/07) that contains the following statement.

> **Procurement**: All future procurement of transformers or any other equipment containing dielectric or hydraulic fluid shall be accompanied by a manufacturer's certification that the equipment contains no detectable PCBs (less than 2 ppm) at the time of shipment. Newly procured transformers and

22 http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/about.htm

23 Puget Sound Naval Shipyard is the remaining US Navy operated repair yard on the West Coast. Planning yard functions transferred from Long Beach Naval Shipyard to Puget Sound in 1995-1996 with the closure of Long Beach Naval Shipyard by the Base Realignment and Closure Commissionl. Its counterpart is Norfolk Naval Shipyard on the East Coast. Puget Sound Naval Shipyard as well as Norfolk Naval Shipyard were involved heavily in the process of identifying PCBs and probable locations in ships being transferred to inactive status.

24 http://doni.daps.dla.mil/Directives/05000 General Management Security and Safety Services/05-00 General Admin and Management Support/5090.1C Instruction and Chapters.pdf or http://www.navy.mil/oceans/5090_1C_Manual.pdf

> equipment no longer require permanent labels stating they are PCB-free (no detectable PCBs); however, activities may find it useful to mark the items non-PCB for inventory purposes.

Due to the nature of the phase out, there is no clear cut period when ships can be defined as manufactured as PCB free until post 1995. The US Navy procurement requirement for certification that products purchased are PCB free allowed for a several year time frame during which parts and materials procured before the certification requirement within the Navy Stores system and Naval Sea Systems Command SPAWARS division could be drawn and utilized for either systems overhauls or shipboard repair. The language of the certification requirement recommends although certified PCB free and not required in purchasing to be labeled PCB free by the manufacturer, items should be marked as PCB free for inventory control purposes. This indicates that PCB containing parts still reside within the inventory control systems of the US Navy.

3. Likely location of PCBs on the HMAS Adelaide prior to the 'preparation' for sinking described in the REF and the URS Report

3.1 General comment: PCBs based on year of construction and shipbuilding practices at the time can be expected in the ships wiring, ventilation gaskets, paints, sound damping tiles. This is particularly the case as the lead time for the quantities of material to be ordered and received to support construction were on the order of 18 months to 2 years ahead of the production requirement. Material procurements began shortly after the order for the ship was placed in 1976 and before the keel was laid in June of 1977. This was prior to Monsanto ceasing production of PCBs in the United States for electrical and electronic applications.[25]

3.2 Comment on the Department of Defence record of known compartments containing PCBs

Defense Letter 2007/1068071/3 FFG SPO/OUT/2008/2339 Paragraph 1 Citation " *Information on hazardous material left in the vessel – The commonwealth is unable to provide this documentation at this stage, as the Commonwealth's removal activities are not yet complete. Documentation will be provided at the time of official handover of the vessel to the NSW Government that details all known hazards. However, based on previous ship disposal activities, it is likely that Asbestos, Zinc Chromate, Polychlorinated Biphenyl and beryllium will be present throughout the vessel. A copy of the latest reports from the Australian Quarantine and Inspection Service are at Enclosure 5"*

Defense Letter - Enclosure (5): The detail list of PCBs on the HMAS Adelaide does address discrete electronic components found in Communication, Radar, Weapon Control Systems.

The statement advising NSW of hazardous materials likely to be found is a general cautioning statement about hazardous materials. It essentially disclaims that the list of discrete locations are the only places where these materials will be found. This is particularly true in light of the gradual phase out of the use of PCBs in electrical materials, as a plasticizer, fire retardant, paint additive and fabrication lubricant. These are distributed uses of PCBs.

Discrete uses of PCBs are applications in which PCBs are restricted to closed and sealed components in an otherwise clean system. These elements can easily be located, removed and packed for appropriate disposal. Discrete uses include:

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[25] Experts experience with material expediters in planning and execution of ship overhauls at Pearl Harbor Naval Shipyard, Long Beach Naval Shipyard, Puget Sound Naval Shipyard, etc. accomplishing ship repair and overhaul.

- capacitors;
- transformers;
- fluorescent light ballasts; and
- equipment rubber sound isolation mounts.

Distributed uses of PCBs are applications which are spread throughout a ship in the materials it is constructed from. These items require removal of the finishing products. They are prevalent throughout the vessel and may be found in nearly every compartment. Distributed uses include:

- electrical wiring – insulation matrix between conductors;
- stuffing tube putty;
- caulking sealing materials;
- tile adhesive;
- insulation materials; and
- ventilation ducting gaskets.

3.3 Estimate of the probable quantity of PCBs onboard the HMAS Adelaide

(a) URS report relied upon the Department of Defense report Encl 6 as well as the 1973 OECD agreement assuming that this meant they did not have to worry about investigating for the presence of PCBs. OECD agreements often take a decade or longer once reached to be ratified. URS indicated that the bulk of electrical cabling had been removed. This would equate to removal of 95-99% of PCBs contained in electrical cables. Based on the experience of ratios for materials identified on Oriskany. Cabling would have accounted for 95% of the PCBs onboard the ship initially. The balance of PCBs would be found in all other sources. With work accomplished as described it is likely that 95%-97% of all PCBs have been removed. No records have been provided relating to tonnage of cables removed and manifested for recycling.

(b) Review of cable transit box photos shows clearly cables that were manufactured in 1977 (see Annexure A to the Affidavit of Mr Quentin Riley, p. 13). Blow up of part of Photo 044 shown below (at Annexure A to the affidavit of Quentin Riley dated 15/04/10, p.13)

LSGU-300-SPL PVC 1977. The jacket is polyvinyl chloride plastic. The black filler shown is the insulation filler matrix between conductors surrounding the individual conductor insulating jackets. The matrix, the individual conductor insulation, and the cable outer covering should each be tested for PCBs. (Blow up of part of Photo 044 shown at Annexure A to the affidavit of Quentin Riley dated 15/04/10, p.13)

(c) Emails (T159 and T142) indicate 73.5 tonnes of Cable were removed. Utilizing the average value for PCBs in electrical cables on USS Oriskany Reefing project, this is a good basis for quantifying an estimate of the total PCBs remaining.

(d) Based on my experience and records from dismantling 4 each Knox Class Frigates at Hunters Point San Francisco, 73.5 tonnes of cabling is a good number. We removed and manifested 200 cy (Cubic yards). This was 4 to 5 each 40 cy roll off disposal containers, weight limited at 20 tons per container.

(e) Estimate of original quantity of PCBs onboard

i) Total original material = 73.5/97% = 75.8 tonne

ii) Estimated PCBs onboard: In absence of a formal testing program to determine PCBs onboard, I will use a composite PCB concentration fraction from USS Oriskany Report to assess. 1493.7 mg/Kg mean PCB concentration of cable insulation materials was the composite concentration average of all cable testing conducted by US Navy. This number may not accurately represent as large diameter power cables with high PCB concentrations (19,000 + mg/Kg) would skew the actual composite number higher than indicated. Navy only averaged the test results and there is no evidence in the article that a weight percent computation was performed.

iii) The overall weight of electrical cables is reduced by 50%, to determine weight of the remaining insulating materials due to the recoverable copper content.

iv) Calculation: Estimated Weight = 37.6 tonne x 0.0014937 kg/tonne = 113 Kg

v) Estimated original PCBs onboard in electrical cabling 113 Kg of PCBs spread throughout the ship. Estimated original total PCBs onboard is 119 Kg

(f) Estimate of current quantity of PCBs onboard

i) Remaining material estimate 3% = 2.2 tonne
ii) Calculation: Estimated Weight = 2.2 tonne x 0.0014937 kg/tonne = 3.4 Kg
iii) Estimated remaining PCBs onboard in electrical cabling 3.4 Kg of PCBs spread throughout the ship.
iv) Assuming a similar ratio to other sources of PCBs (worst case) as with the Ex USS Oriskany Reefing Project. Total estimated PCBs remaining onboard subject to potential release to the local environment over time are 9.4 Kg (20.7 lbs).

(g) Estimate Check: This corresponds to the relative quantity estimated by US Navy of 328 Kg (722.6 lbs) of solid PCBs remaining on Ex USS Oriskany when reefed in 2006. Displacement scaling would indicate that we should expect to find approximately 16.4 Kg of solid PCBs after reefing preparations are complete.

4. Likely location of PCBs on the HMAS Adelaide after the 'preparation' for sinking described in the REF and the URS Report (Polglaze).

4.1 Likely location of PCBs on HMAS Adelaide after preparation for sinking as described.

(a) Cable transit boxes where electrical cabling has been cut back to. (Estimate that this would likely constitute 30 to 40% of the remaining PCBs)
(b) Ventilation felt PCB impregnated gaskets. Although PCB manufacturing was banned in 1979 by the EPA. This is an instance where EPA allowed prevailing practice to continue until stocks were exhausted. Testing of a representative number of gaskets should be accomplished. (Estimate that if construction utilized PCB impregnated felt gaskets this will constitute 40 to 50% of the remaining PCBs) - All other materials would constitute approximately 10-20 percent of the remaining PCBs
(c) Rubberized caulking sealing materials.
(d) Stuffing tube packing putty
(e) Rubberized sound isolation mounts.
(f) Deck tile adhesives (unlikely that any would remain due to the periodic habitability renovation which occurred over the years. I would expect that the ship's deck coverings would have been replaced between two to three times or more since commissioning. This would have entailed removals of underlayment down to bare steel.
(g) Lagging pin adhesive (much of this may be remaining).
(h) Double backed adhesive tape used for installing label plates.
(i) Insulation- bulkhead thermal fibre glass – PCB sampling entails sampling of the entire material not surface swab samples of the paint on the surface of the material. Bulkhead fibre glass type material. Original glass material contained PCBs as a fire retardant.
(j) Insulation – in motor rotor and stator insulation.
 i) 84 motors for pumps
 ii) 4 ship service diesel generators
 iii) __(estimate 50)____ number of ventilation fan motors. Would need a copy of the ship's damage control manual to identify number of ventilation fans and their locations.
(k) Sand tile sound damping tiles

(l) Habitability paint and foam plastic insulation. PCBs were added for flammability protection.

5. PCB testing conducted by AIRSAFE for McMahon Services Australia (detailed in the AIRSAFE report of 3 March 2010).

5.1 Suitability of testing methods. Swab method utilized only detects surface PCB contamination from liquid PCBs. It does not detect anything in the covering fabric or the insulation material underneath the paint surface. No evidence of chain of custody or the sampling procedure used to obtain the samples in the reporting. There are at least 3 entities involved in the testing with no chain of custody documentation. An unbroken chain of custody is required to maintain evidentiary validity. At best the test results say they found no surface contamination on top of the paint. The tests accomplished do not say anything about the composition of the paint, the insulation surface materials, or the insulation itself. Each layer requires a separate bulk sample to be analyzed for PCBs.

5.2 Comprehensiveness of sampling

The sampling was not comprehensive – in dealing with a ship of this size a comprehensive test plan would require:

- Testing one sample of each type of electrical cable, ventilation gaskets, damping tiles, rubberized components, insulating materials, adhesives, and paints. Testing is not required if the manufacturing data on the cable can be read and cable looked up as to whether PCB free or not.
- Minimum Total Number of Samples (T) - is the larger of fifteen samples or the square root, rounded off to the to the nearest whole number, of the gross weight of the vessel in long tons (2,200 pounds equals one long ton). For Adelaide this is sqrt(4100) = 64 samples.[26]

6. Characteristics of a sampling program that would adequately determine the presence or absence of PCBs on the HMAS Adelaide after 'preparation'

6.1 Standard practice sampling methods for assessing presence of PCBs on ships.

(a) The two recommended sampling methods consist of

i) NAVSEA ADVISORY 95-1 PCBs – Provides a specific guide.

ii) 1995 EPA Draft Guidance developed for export of ships (Updated 2004) based on statistical investigation program as a minimum to certify a ship for export.

(b) These sampling methods are the only means of complying with the US EPA requirement to insure that vessels being exported for scrapping/reefed/or sunk in military live fire exercises do not have PCBs onboard ≥ 50 mg/Kg. They represent the required minimum required guidance.

[26] 1995 EPA Draft Guidance developed for export of ships

6.2 Details of sampling required to adequately determine presence of PCBs on Ex-HMAS Adelaide. The sampling areas are broken into 3 Strata based on relative importance by quantity likely to be encountered
   (a) Strata I – Electrical Cables
   (b) Strata II – ventilation or air handling system flange gaskets
   (c) Strata III – all other applications (rubber, paint, adhesives, insulation, foam etc).

Total vessel sampling materials	T = sqrt (4100) = 64 consisting of : Strata I - At least 0*.4 (T) = (0.4)x(64)=26* electrical cable samples shall be taken. Each non-conducting material (plastic, rubber, etc.) from each electrical cable shall be chemically analyzed separately. Three fourths of the total electrical cable samples or O.3(T)=(0.3)x(64)=20 samples shall be taken from electrical cable in engine compartments, auxiliary machinery compartments, areas having radio transmission and receiving equipment, x-ray equipment, radar equipment, and any other high voltage electrical equipment. Strata II - At least *O4 (T = (0.4) x (64) = 26)* samples shall be taken from gaskets in air handling systems. One half of the air handling system samples or at least O.2 (T) = (0.2) x (64) = 13 samples shall be from air handling systems gaskets in: engine compartments, auxiliary machinery compartments, and in areas where their fuel, explosives and munitions were stored and handled. Strata III -At least O.2 (T) = (0.2) x (64) = 13 samples shall be taken from this stratum. In the event that 0.2 (T) ≥ 9, one sample shall be taken from each of the following nine groups (substrata): rubber gaskets (other than air handling system gaskets); felt gaskets (other than in air handling system gaskets); thermal insulation material (fiber glass, felt, foam, and cork thermal insulation material); sound deadening felt; grouting/caulking, rubber isolation mounts, foundation mounts, and adhesives; tapes; oil-based paint in containers (paint on surface of the vessel is not included); pipe hangers; and rubber and/or plastic parts of all sizes/shapes (other than listed in stratum 1, stratum 2, or the preceding nine substrata in this stratum). In the event that there is an insufficient number of samples or 0.2 (T) < 9, the O.2 (T) samples shall be randomly selected from a numbered list of the nine substrata.
Sampling methods (collection)	See Annexure C - NAVSEA ADVISORY 95-1 Generic Sampling Plan for sample collection developed by Norfolk Naval Shipyard. This Sampling Method can easily be tailored to the HMAS Adelaide utilizing the above test sampling regimen. Sampling procedures provide for specific collection methods, There should be precautions to prevent cross contaminations of samples. Sampling agency should identify a primary lab for the full sampling array[27] including blanks as well as a validating lab until confidence is established regarding the primary lab.
Chain of custody	Sample Chain of custody (Annexure F)

[27] Set of all samples and all tests to be conducted on each sample calling out which lab test method is to be accomplished.

Laboratory Test methods	EPA Waste Characterization **SW-846** Method 8082A**: Polychlorinated Biphenyls**[28] for The Total Threshold Limit Concentration (TTLC) [29] and Waste Extraction (WET), Citric Acid or DI[30] Water by Title 22 and Chlorinated Pesticides & PCBs by EPA 8081/8082. PCBs are hazardous waste constituents in California's Toxicity Characteristic. The TTLC for PCB in waste is 50 mg/kg, and the Soluble Threshold Limit Concentration (STLC)[31] is 5.0 mg/L. Waste streams must be characterized utilizing both techniques to manifest to disposal site in California. Most restrictive method shall apply.

6.3 Was PCB sampling undertaken on Ex-HMAS Adelaide consistent with best practice?

(a) Sampling accomplished at best was only a test to detect surface contamination resulting from a leak and is not consistent with best practice. To detect solid PCBs each component of a material must be tested. In the case of a bulkhead insulation system you would test the mastic[32] under the lagging pins[33], the fibre glass material itself, the glass surface material, and the paint system on top. In the case of an electric cable you would test the cable jacket, filler matrix, and the individual conductor jackets. Sampling and testing of paint systems requires a representative sampling of each type of paint onboard coupled with sample compositing[34]. If the composite generates a positive result then the constituents of forming the composite are tested to isolate the problem.

7. Methods available to remove all PCBs from the Ex-HMAS Adelaide

7.1 Best practice methods for removal of PCBs from ships

(i) Accomplish a survey to determine remaining PCBs in accordance with sampling program above.

(ii) Remove all vent duct flanges containing material identified as containing PCBs – removal entails cutting with a SawsAll approximately 7 to 10 cm on each side of the ventilation ducting flanges. Flanges are then packed into drums and shipped for disposal.

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[28] http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/8082a.pdf

[29] TTLC - Total threshold limit concentration. A State method and value for determining if a waste is hazardous. Specifically, TTLC means the concentration of a solubilized, extractable, and nonextractable bioaccumulative or persistent toxic substance which, if equaled or exceeded in a waste or waste extract, renders the waste hazardous (California CCR Title 22, section 66260.10, p. 645.)

[30] DI – distilled water (pure water)

[31] STLC - Soluble threshold limit concentration. A California State method and value for determining if a waste is hazardous. Specifically, STLC means the concentration of a solubilized, extractable, and nonextractable bioaccumulative or persistent toxic substance which, if equaled or exceeded in a waste or waste extract, renders the waste hazardous (California CCR Title 22, section 66260.10, p. 645).

[32] Mastic – def - adhesive

[33] Lagging Pin – pin with a metal base glued to the ship's structure to hold insulation. Insulation material is pressed onto the pin and secured with a press on metal button approximately 1" in diameter.

[34] Sample compositing: samples are taken from multiple locations. Equal weights of each sample are taken and mixed. The composite sample is tested. If negative all samples are clean. If positive then each component sample is tested. This minimizes overall testing costs if the extent of a problem is not known.

(iii)Remove cable stubs in bulkhead cable transits. The transit can be either cut out or disassembled by loosening stuffing rings/clamps and punching cable stubs out. Remove any packing materials.

The above cables and packing can be removed from the cable transit box by backing off the clamping bolts and punching out the packing materials and remaining cable. (see Annexure A to the Affidavit of Mr Quentin Riley, p. 9) Excerpt from Photo 040 (Annexure A, p.9).

The above packing gland nuts can be backed out and the cables removed. In the adjacent vertical transit box, undo the clamping bolts and remove the cable and packing. Remove any insulation identified as PCB containing. (see

Annexure A to the Affidavit of Mr Quentin Riley, p. 6) Excerpt from Photo 055 (Annexure A, p.6).

(iv) Remove items secured with PCB adhesives utilizing ultra high pressure water. Note that if the vessel is recycled, these do not need to be removed as they are destroyed during smelting process. This is an industrial version of a household pressure washer for cleaning your house utilizing a water jet at 10,000 to 40,000 psi water versus 1,000 to 3,000 psi.

(v) Remove PCB containing paints utilizing ultra high pressure water hydroblast (10,000 to 40,000 psi). (Note: this same method can be utilized to remove zinc chromate paints if found to have levels above TCLP limit which would trigger a dumping requirement.

7.2 Was removal of PCBs from Ex-HMAS Adelaide consistent with best practice?

(a) Adelaide PCB removal was not consistent with best practice. No formal survey was accomplished to assess extent of PCBs remaining on the vessel based on an erroneous assumption. Best practice would have been to survey, remove all materials identified, and finally, accomplish a clearance survey to verify work.

7.3 Comments on likely structural integrity after complete removal of PCBs

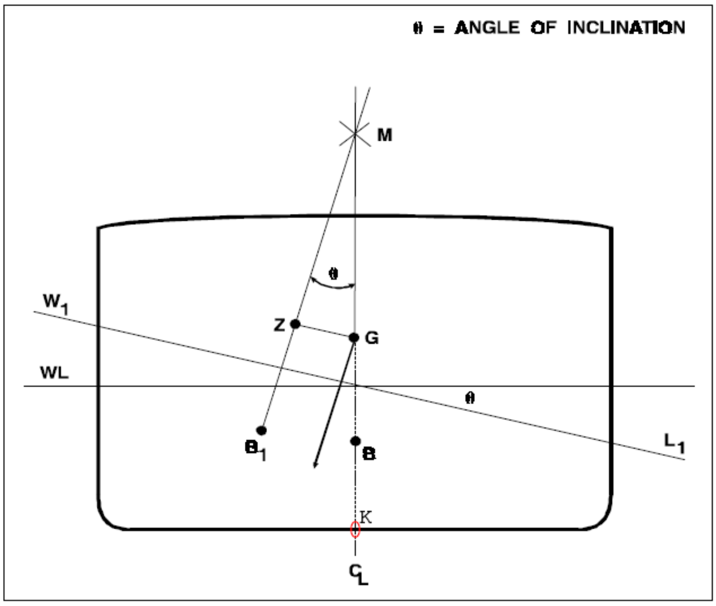
Reefing Tow Plan - Preparations made for reefing by cutting divers accesses and removal of watertight doors which could trap divers have been accomplished. Tank covers have been removed and bars installed to prevent access. This provides free flood paths for placement of the vessel when the scuttling charges are set off. Cutting out fore aft transit boxes or removal of vertical cable penetrations would not affect the ship for planned reefing. The relative area as compared to the penetrations established for divers is estimated at less than 1% based on review of the reefing preparation drawings.

Ocean Tow: The ship no longer has any watertight integrity for purposes of ocean tow. Ocean tow requires that condition “Zebra” be set. This is the damage control condition for maximum watertight integrity where all hatches, watertight doors, scuttles are closed, dogged and checked to insure no leakage. All piping system valves are closed at manifolds and bulkhead stops to prevent possible cascade flooding. As the vessel is currently configured, it would require an extensive effort to re-establish water tight integrity of the ship. The ship in current configuration for reefing is not safe for ocean tow.

A survey by a qualified marine surveyor specializing in Ocean Tow preparation would be required to determine minimum requirements to re-establish watertight integrity for ocean tow.

For a vessel not already prepared for reefing, removal of transit boxes and stuffing tubes followed by a 3 to 6 mm blank plate depending on area to be covered, bolt, strongback with silicon caulking would restore watertight integrity of bulkheads/decks at locations cables have been removed from transit boxes and stuffing tubes.

Ship stability: Vessel minimum stability required for tow is a Metacentric Height (GM) of 2.5 ft = 0.76 m. GM is defined as the Ship’s Transverse Metacentric Height (KMt) – Ship’s vertical center of gravity (KG). The metacentric height, measured in feet, is the distance between the center of gravity and the metacenter and is the principal indicator of initial stability. A ship whose metacenter lies above the center of gravity has a positive metacentric height and is stable; conversely, a ship with the metacenter below the center of gravity has negative metacentric height and is unstable. A GM of +2.5 ft provides sufficient stability for tow. Vessel should be ballasted by the stern 1 m per 100 m of length. (1 ft/100ft of length)



8. Possibility of PCBs leaching into the environment, if the vessel were sunk in its current condition

In my opinion the possibility of leaching into the environment is highly probable based on the limited environmental monitoring accomplished to this point in time related to reefing projects. The only project monitored to date is the USS Oriskany reefing project in Florida, USA, **PCB Monitoring on the Oriskany Reef** (Part II. Initial Sampling Event) By Jon Dodrill Florida Fish and Wildlife Conservation Commission and Robert Turpin Escambia County Marine Resources Division.[35]

Report summary "During the initial sampling event of December 14, 2006, no gray triggerfish were caught. Red snapper dominated the landings with thirty legal size red snapper retained. Red snapper total lengths with two exceptions suggested specimens were in the 2-4 year old age classes. With the exception of two larger red snapper specimens (808 mm and 795 mm, total length) that entered one of the chevron traps together, the remaining red snappers kept for PCB analysis were at or just above the minimum legal size of 406 mm (16 inches total length) (range 404-475 mm). The remaining 20 discarded red snapper were 25-50 mm be-low legal size. An additional 12 juvenile red porgy, and a sublegal almaco jack were also discarded. Fifteen of 30 fish had total PCB levels exceeding 20 ppb with the average total PCB concentration value at 34.137ppb. Six of 30 fish had PCB levels ranging from 68.0 to109.8 ppb that exceeded the recommended 50 ppb PCB Florida Department of Health (DOH) fish consumption screening limits."

The concentrations of PCBs found in the Oriskany Reef environment are positive evidence of PCBs leaching into the local biosphere. The study did not evaluate Chromium or Lead in the local environment as a consequence of reefing.

[35] http://www.sdafs/FLAFS/PDF/October 2008 Issue.pdf

The Mackenzie reefing program in British Columbia did not accomplish any post reefing monitoring for PCBs. Ships were prepared to the standard required by Environment Canada Guidance – "Clean-Up Standard for Disposal at Sea of Vessels, Aircraft, Platforms, & Other Structures" Rev 3 December 2007 Environment Canada Pacific and Yukon Region. I confirmed this 3/29/2010 with Bruce Clark at Fisheries and Oceans Canada Oceans, Habitat, and Enhancement 604-666-6140 fax: 604-666-6627 Email: bruce.clark@dfo-mpo.gc.ca. Also Mr. Shawn Standing, at Environmental Canada phone 604-666-2730 confirmed that no testing for PCBs had been accomplished.

No objective evidence from the Canadian Reefing projects is available as no testing programs were funded or accomplished.

In the case of USS Oriskany the majority of PCBs remaining onboard were from cabling sources not removed.[36] The bulk of accessible cables were cut and removed. Cable removal practices was to cut cables identified as PCB containing at the transit boxes as part of the preparation to reduce the quantities of PCBs remaining onboard. U.S. Navy Inactive Ship Cleaning Practices illustrates removal of exposed cableways and reefing preparations accomplished on the USS Oriskany in preparation for reefing. This is similar to the preparation described as accomplished on the HMAS Adelaide. Modeling Adelaide as similar in construction methods and maintenance practices 95%+ of PCBs remaining onboard would be from transit box stubs and from ventilation gasket materials.

Note: Oriskany Cableway stripped of all cables in back corner of compartment.

[36] PCB Monitoring of the Oriskany Reef http://www.sdafs/FLAFS/PDF/October 2008 Issue.pdf
US Navy Inactive Ship Cleaning Practices http://www.rabnewportri.org/enclosures/Sept2009Encl2.pdf

Stripped insulation and electrical cabling in island

Illustration from US Navy Inactive Ship Cleaning Practices – USS Oriskany reefing preparation.

9. Options for recycling the vessel or parts of the vessel

9.1 Part of evaluation of the disposal options for a vessel includes a determination of the recoverable resources. Based on the current market for recycled materials the author accomplished the following analysis. This is a routine analysis for evaluation of bidding ships for disposal. Coupled with this are the value of the energy resource saved by recycling, and indirect value, and the Carbon Dioxide (CO_2) emissions saved through recycling. The value of the latter is not currently quantifiable as a monetary value but should be considered in the overall project environmental evaluation by the agency approving the project. Under a cap and trade regimen, Carbon credits would be generated having a monetary value.

Materials estimate for value of Materials in HMAS Adelaide using parametric estimating for warship content. I use the Rand 2001 Report for Disposal Options for Ships Table B.10 for this estimate.

Table 9.1a
Recovery Indices for Ship Types

	Ferrous	Aluminum	Copper and Copper Alloys	Lead	Waste
Surface combatants	79	4	4	4	9

Full Displacement	4100 LT					
Light Ship Weight*	2648 LT	Light Ship Fraction	Weight (tonne)	Value US$	Unit	Extended Value
Waste Stream		9%	254.2	$0.00		
Ferrous		79%	2144	$400.00	tonne	$857,600.00
Aluminum		4%	108.6	$2.00	lb	$477,840.00
Cu		4%	108.6	$3.60	lb	$860,112.00
Pb		4%	108.6	$1.00	lb	$238,920.00
					Total	$2,434,472.00

Light Ship Weight – No Fuel/Equipage/Ballast/Water/Oil ~ 2,648 LT[37]

Market value of the vessel recoverable materials as is = US$ 2,434,472.

[37] Disposal Options For Ships – FFG-7 Light Ship Weight in Long Tons

9.2 Of additional concern is the requirement for processes and activities to evaluate Carbon Dioxide (CO2) emissions. The governing drivers for activities in California are:

(a) Based on the 2007 Supreme Court Decision Carbon Dioxide emissions are considered a regulated pollutant (Massachusetts Vs EPA No. 05-1120). Contributions to global warming must be considered in evaluation of the least damaging alternative under this decision. The California Attorney General has provided 180 day notice of intent to sue 31 July 2008 regarding as unreasonable the failure of the EPA to provide rules regulating CO_2 emissions. Under the Supreme Court Decisions the following would apply.

i) Clean Air Act Title I Part A Air Quality and Emission Limitations – Section 109 National Air Quality Standards and section 112 Hazardous Air Pollutants

ii) Clean Air Act Title I Part C Subpart (1) Prevention of Significant Deterioration of Air Quality

Table 4.7-1. The pollutants that are considered in this analysis include ozone (O3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate matter smaller than 10 microns in diameter (PM_{10})

iii) Although rules have not been established regarding CO_2 emissions by the EPA it is highly desirable through planning and appropriate evaluation to minimize such emissions where possible. In the case of dredging minimization of CO_2 emissions contributing to Global Warming, acid rain, and increased ocean acidity will be a trade off evaluation between the requirements of the Clean Water Act and the Clean Air Act with respect to the final Least Damaging Alternative.

iv) On September 22, 2009, EPA released final regulations that require approximately 10,000 facilities to report their greenhouse gas (GHG) emissions annually. Covered facilities must begin monitoring January 1, 2010, and file their first annual reports by March 31, 2011. The reporting rule generally applies to facilities that emit more than 25,000 tons of GHG a year, although some sources with lower emissions also will be subject to the rule. EPA estimates that the reporting rule will cover about 85 percent of GHG emissions in the United States.[38]

(b) ***The Kyoto Protocol*** treaty was negotiated in December 1997 at the city of Kyoto, Japan and came into force February 16th, 2005.

"The Kyoto Protocol is a legally binding agreement under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990 (but note that, compared to the emissions levels that would be expected by 2010 without the Protocol, this target represents a 29% cut). The goal is to lower overall emissions from six greenhouse gases - carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, HFCs, and PFCs - calculated as an average over the five-year period of 2008-12. National targets range from 8% reductions for the European Union

[38] http://www.martenlaw.com/newsletter/20090923-epa-issues-ghg-reporting-rule

and some others to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland."[39]

Disposal at sea of a recyclable resource involves generation of significant quantities of CO_2 to replace that resource. Under the goals of the Kyoto protocol consideration should be given to minimizing CO_2 emissions where practicable.

(c) **Relationship to the National Energy Policy:** On August 4, 2007, the House passed HR 3221, the New Direction for Energy Independence, National Security, and Consumer Protection Act. Oversight and Government Reform Committee, Carbon-Neutral Government – Title VI (http://speaker.house.gov/legislation?id=0076)

i) To make the federal government a leader on reducing global warming, this title sets an ambitious goal requiring federal government operations to be carbon-neutral by 2050, with annual government-wide emissions targets. The federal government is the largest energy consumer in the United States.

ii) Under the legislation, federal agencies must inventory their greenhouse gas emissions, freeze emissions in 2010, and then reduce net emissions by at least two percent each year to achieve zero emissions by 2050.

iii) The title contains new energy and fuel efficiency policies for federal operations, including minimum greenhouse gas emissions standards for federal fleet vehicles, green building standards for new federal buildings, and expanded authority for agencies to purchase renewable energy.

Under HR3221 consideration to minimize petroleum usage is strongly emphasized. Each barrel of fuel not utilized equates to a reduction of imported oil by 1.25 to 1.66 barrels of oil. HR3221 also seeks to reduce CO_2 emissions as a consequence of regulatory process (government decision making processes).

(d) **Relationship to California Energy Policy:** Specifically, AB 32, the California Global Warming Solutions Act of 2006, requires CARB to:

- Establish a statewide greenhouse gas emissions cap for 2020, based on 1990 emissions by January 1, 2008.
- Adopt mandatory reporting rules for significant sources of greenhouse gases by January 1, 2009.
- Adopt a plan by January 1, 2009 indicating how emission reductions will be achieved from significant greenhouse gas sources via regulations, market mechanisms and other actions.
- Adopt regulations by January 1, 2011 to achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas, including provisions for using both market mechanisms and alternative compliance mechanisms.
- Convene an Environmental Justice Advisory Committee and an Economic and Technology Advancement Advisory Committee to advise CARB.
- Ensure public notice and opportunity for comment for all CARB actions.
- Prior to imposing any mandates or authorizing market mechanisms, CARB must evaluate several factors, including but not limited to impacts on California's economy, the environment and public health; equity between regulated entities; electricity reliability, conformance with other environmental laws and ensure that the rules do not disproportionately impact low-income communities.

Under AB32 consideration to minimize petroleum usage is strongly emphasized. Each barrel of fuel not utilized equates to a reduction of imported oil by 1.25 to 1.66 barrels of oil. AB32 also seeks to reduce CO_2 emissions as a consequence of regulatory process (government decision making processes).

[39] http://www.kyotoprotocol.com/

9.3 Comparison of the carbon footprint of recycling materials from the vessel with the carbon footprint of manufacturing new materials to determine both emission avoidance as well as evaluation of energy required to be imported.

The following table identifies energy savings for recycling various materials versus making new from DAKOFA[40] MEMO: Waste & Climate Change Background document for the ISWA & DAKOFA conference on Waste & Climate Change 26-27 November 2007 in Copenhagen - *held in connection to the UN Climate Summit COP 15 in Copenhagen 30 Nov. – 11 Dec. 2009*

[40] DAKOFA - Danish Competence Centre on Waste http://www.avfallnorge.no/index.php/kurs_og_seminarer/internasjonale_arrangementer/iswa_dakofa_waste_and_climate_conference_copenhagen_2009

Table 9.2a: Saved CO2 emissions and saved 'hidden flows' in recycling compared with virgin manufacture

Material type	Virgin Material Production Cost (t/t)	Recycling energy savings	**Saved CO2 emission in recycling compared with virgin manufacture (t/t)**	**Saved 'hidden flow generation' in recycling compared with virgin manufacture (t/t)**
Copper	19.7	95%	13-19.7	346.04
Aluminum	12.4	95%	4.6-12.4	36.15
Steel	1.9 -2.5	75%	0.9-1.3	7.85
Plastic			1.7-4.7	
Paper and cardboard			1.3-1.7	1.04
Glass			0.6	2.17

Table 9.2 b Estimate of CO2 Generation Avoidance by recycling materials[41]

Material	Sym	Qty (tonne)	CO2/tonne virgin material	Recycling efficiencey with hidden energy flows	CO2 Emisions avoided by recycling (tonne)
Aluminum	Al	108	12.4	0.95	1272.24
Copper/Brass	Cu	108	19.7	0.95	2021.22
Lead	Pb	108	1.63	0.99	174.42
Steel	Fe	2144	2.5	0.75	4020
Total					7487.88

Estimate of Energy Savings by recycling

Energy Savings – convert CO2 emissions to equivalent Diesel 10.1 kg/gallon[42]

Fuel equivalent = 7,500 / 10.1 kg/gallon = 741,000 gallons

Convert to estimated Crude Oil required = Diesel/0.8/42gal/barrel

= 22,000 barrels crude

Estimated value of Energy Savings at current world Crude Prices.

Current value of resource NYEX (2 April 2010) @ US$ 84.87 Barrel[43]

22,000 barrel x 84.87/Barrel = US$ 1,870,000

[41] Table developed by author utilizing Table 9.2a and Table

[42] http://www.epa.gov/oms/climate/420f05001.htm

[43] Price as of Apr 5, 2010 http://www.bloomberg.com/markets/commodities/energyprices.html

10. Additional comments: As a marine professional having worked in both ship repair and disposal, the following are of concern due to regulatory requirements in ship disposal in the US/California and or are of concern due to gas free/safety issues in ship disposal either for dismantling or reefing.

10.1 Heavy metals are of concern is a ship disposal process. Regulatory levels for waste stream contamination require special treatment when these metals exceed EPA defined thresholds under RCRA typically these numbers run between 5 and 10 mg/Kg. The following comments regard the Commonwealth of Australia Department of Defense Letter regarding presence and locations of Hazardous Materials to New South Wales.

(a) Chrome (Cr) and Zinc (Zn) – although the cautioning statement exists it is with respect to:

   i) Chrome/Zinc (Cr/Zn) in paints primarily utilized internally in the deckhouse superstructure – Paint sampling survey of vessel required to establish extent and estimated quantity. Paint test to establish estimated leachable quantity.

   ii) The statement and inventory do not address zinc as discrete metal utilized in sacrificial anodes in the salt water sides of heat exchangers.

(b) Not included in the Department of Defense letter statement of hazardous materials even as a general caution are the following metals of concern under RCRA [44]

(c) RCRA (8) metals are: Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver.

(d) Arsenic, Barium, Cadmium, Selenium, Silver, as well as other recoverable heavy metals are found as constituents in electrical and electronic waste streams, primarily circuit boards and semiconductor technology. These would be primarily located in the ship's communications, radar, weapons control and propulsion control systems. Lead (Pb)

   i) Lead (Pb) in paints – Paint sampling survey of vessel to quantify where and how much. Total leachable content is required to determine whether disposal without removal is classified as dumping. Paints if greater than 5 mg/Kg Pb are classified as EPA regulated.

   ii) Journal bearings – Lineshaft bearings – requires detail drawing of line shaft bearings to determine composition and quantity. A wide variety of Babbitt[45] alloys exist. Some common compositions are:

   - 90% tin, 10% copper
   - 89% tin, 7% antimony, 4% copper
   - 80% lead, 15% antimony, 5% tin
   - A lead-based based Babbitt (75% lead, 10% tin)
   - A copper-lead based Babbitt (76% copper, 24% lead)
   - A copper-lead-tin based Babbitt composed of (67% copper, 28% tin, 5% lead)

   iii) Fixed ballast – Based on Fixed Ballast drawing FFG7-191- 8600238 Rev4 there is 43.1 tons of Lead (Pb) ballast installed in clean ballast tank 5-116-0-W in the form of 1728 each 56lb ingots and 108 each 18.7 lb ingots. Contract AD0801 Vol2 L. Review of the weight and moment addition/removals 2008 Contract AD0801 Vol2 F found no indication of the removal of 43.1 tons (86,200 lbs) of Lead (Pb) in preparation for reefing. Review of daily worksheets of material removed from the ex-HMAS Adelaide (from Aug 2009 to Feb 2010) identified

[44] Resource and Conservation Recovery Act of 1976.
[45] Babbit – Soft alloy metal lining of a journal bearing lubricated by oil. Bearing and shaft are separated by an oil film.

73.223 tonnes of Lead (Pb) removed. This value is approximately the weight expected based on a 1994 NAVSEA FFG-7 Class weight and stability situation report #11 for U.S. ships. Total ballast ranges were 35 to 145 long tons. It appears that ballast lead was satisfactorily removed based on the weight removal log.

iv) Battery connection leads, battery locker liners, sonar dome sound damping tiles, heater coils in drains, etc.

(e) Cadmium (Cd)

i)

- Cadmium clad fasteners utilized in high temp applications.
- Puget Sound Naval Shipyard also found Cd in paints, adhesives and Mastics.

10.2 Organotin – sonar dome rubber window and paints. The sonar dome and transducer array was removed in 2008 by the RAN. No paint sampling was accomplished to characterize the ship's hull regarding quantity of leachable metals present in the antifouling system.

10.3 Rust Preventative Compound

(a) Rust preventive compound is a preservative utilized inside of inaccessible voids on ships to prevent corrosion. It is used to flow coat the inside of rudder, fin stabilizers, bilge keels, docking keel, bow leading edge inaccessible void, and inaccessible voids in the vicinity of the rudder under the steering gear room. In the case of the Adelaide the rudder, and fin stabilizer were removed in 2008 at the RAN repair yard. See Annexure G for MSDS and Drawing illustrating locations.